HIGH SPEED LASER MARKING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to laser marking systems. More specifically, the present invention relates to methods and apparatus for the high speed generation of character or symbol patterns used to mark objects by means of focused laser radiation.

While the present invention is described herein with reference to illustrative embodiments for particular applications, it should be understood that the invention is not limited thereto. Those having ordinary skill in the art and access to the teachings provided herein will recognize additional modifications, applications and embodiments within the scope thereof.

1. Description of the Related Art

Laser marking systems are known in the art. At or about the time of the filing of the present application, the Markem Corporation of Keene, N.H. was engaged in the manufacture of a system which reflected the state of the art in laser marking tools. In general, laser marking tools are used to etch an identifying symbol or set of symbols on a surface or object. In certain applications, high speed is required to make a number of marks on a number of articles of manufacture.

At least two marking techniques are known in the art. The first involves the writing of each character or symbol in a script style. The other involves the stenciling of each symbol or character by a pulsed laser beam. The stenciling technique involves the use of a mask wheel which has a peripheral template with a plurality of transmissive character or symbol pattern apertures. The mask wheel is spun into position and the laser is activated to generate the desired character at the target.

The writing technique is most often used, as it requires much less power than the stenciling technique. The stenciling technique, however, is faster. Unfortunately, there are problems with the stenciling technique that have heretofore limited its utility for the high speed applications mentioned above. For example, the high beam power required for the high speed stenciling of metallic, ceramic or glassy surfaces tends to damage the transmissive stencil. This in turn necessitates the use of large aperture patterns for stencils to reduce the radiant energy density on the aperture mask. When the resultant large diameter mask wheel is spun at high speeds coincident with high laser pulse repetition rates, centrifugal forces are generated which can cause the wheel to rupture.

Further, the marking of metals, ceramics and glassy surfaces requires laser radiation of short wavelengths to maximize energy coupling into the target thereby minimizing the total required energy. This necessitates the substitution of high temperature tolerant refractive elements in the stencil when alternate high power short wavelength laser sources are used.

There is therefore a need in the art for a high speed laser marking apparatus and technique which does not require costly maintenance and substitution of the symbol mask.

SUMMARY OF THE INVENTION

The need in the art is addressed by the high speed laser marking system of the present invention which includes a laser for generating a beam of electromagnetic energy and symbol generating means for forming the image of a symbol on a target. The symbol generating means includes an element for reflecting one of a number of images of the symbol on the target and means for selecting any one of the symbols to be reflected at a time.

In a specific embodiment, the invention includes a wheel on which a plurality of mirrored elements are disposed. The wheel is driven under control of a conventional control system to provide for the irradiation of a selected symbol. In a more specific embodiment, the invention includes an ellipsoidal mirror to direct the reflected radiation to the target. A further more specific embodiment of the invention includes mirrored reflective elements designed to reflect mirrored or holographic images of selected symbols to the target.

DESCRIPTION OF THE INVENTION

A typical stencil type laser marking system **11** constructed, in accordance with the teachings of the related art, is shown in FIGS. **1**(*a*) and **1**(*b*). The system **11** includes an input device **13** which provides for symbol selection. The input device **13** may be a switch from a keyboard, a memory device, or other input device as is known in the art. The input device **13** provides the selected symbol to a controller **15**. The controller **15** is coupled to a motor drive **17** for a stepping motor **19**. The stepping motor **19** has a shaft **20** extending therefrom which is connected to a wheel **23**. The controller **15** may be implemented by a lookup table stored in a read-only-memory (not shown). As shown in FIG. **1**(*b*), the wheel **23** has a plurality of transmissive character apertures **24** mounted about the periphery thereof.

In operation, the controller **15** sends appropriate signals to the motor drive **17** to activate the stepping motor **19** to position the wheel **23** so that light in a beam **22** from a laser **21** may illuminate the selected character **24**. Light in the beam **22** is then focused by a lens **25** onto a target **30**. A high energy laser light pulse is timed to occur at the same instant as the selected character appears in the laser beam.

As discussed above, there are numerous disadvantages associated with the conventional aperture system of FIGS. **1**(*a*) and **1**(*b*). For example, the high beam power required for high speed stenciling of metallic, ceramic or glassy surfaces tends to damage the transmissive stencil apertures **24**. This in turn necessitates the use of large aperture patterns for stencils to reduce the radiant energy density on the aperture mask. Unfortunately, when the resultant large diameter mask wheel is spun at high speeds to coincide with a high pulse repetition rate laser, the perforated wheel can rupture due to centrifugal forces. Further, in the case of a solid transparent stencil wheel the transparency characteristics of the wheel must be matched to the laser wavelength. The wheel must often be changed to accommodate lasers operating at other wavelengths. In addition, aperture systems are limited to stencil type alphabets and symbols.

The advantageous operation afforded by the present invention addresses these shortcomings of conventional high speed laser marking systems. As shown in the illustrative embodiment of FIG. **2**, the high speed laser marking system **32** of the present invention employs a reflective character template wheel to form characters and symbols on the target **30**. In the design of the present invention, there are no lossy or sensitive refractive